DEGRADATION OF MID-LATITUDE CRATERS ON MARS. Daniel C. Berman, David A. Crown, and Leslie F. Bleamaster III, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ, 85719, bermandc@psi.edu.

Introduction: The degradation of craters in ice-rich environments is key to understanding the geologic history of the terrain surrounding the crater, as well as the source of the ice (i.e. ground ice or emplaced from the atmosphere as an ice-rich mantle [1-3]). Features such as arcuate ridges, gullies, and small flow lobes found on crater walls and floors can be used to understand the styles of emplacement, abundance, and distribution of the ice. Previous studies [4] have shown that arcuate ridges and gullies are mainly found in small craters (~2-20 km in diameter); the orientation of these features on crater walls has been found to be dependent on latitude, suggesting that their formation is related to climatic changes driven by obliquity cycles [1-7]. In larger craters (~20-100 km in diameter), potentially ice-rich flow lobes are typically found on pole-facing walls, along with a suite of other degradational morphologies indicative of ice-driven modification processes. In this study, we examined larger craters in detail, noting the potentially ice-rich morphologies present and assessing their relationships to latitude and crater diameter.

Crater Morphologies: ArcGIS was used to integrate available datasets (including Viking Orbiter MDIM 2.1 and THEMIS IR mosaics, MOLA 128 pixel/degree DEM, and THEMIS VIS images) to complete surveys of two study regions. Every crater larger than 20 km in each region (as identified in the Barlow martian crater database [8]) with sufficient image coverage was studied in detail for evidence of flow features and related morphological indicators of ice-rich deposits. The geomorphic characteristics of each crater were noted to determine relationships between the observed features and factors such as crater diameter, latitude, and wall slopes. The rims of these craters are typically highly degraded and dissected, in contrast to smaller craters in which arcuate ridges and gullies are typically found. The wall slopes typically range from ~10-20º.

A series of landforms exist on crater walls and floors indicative of the presence of water or ice, including lobate flows; narrow channels within and around the crater; trough-like crater-wall valleys (sometimes filled with mantling deposits); gullies (with accompanying fans and alcoves); filled and unfilled alcoves; arcuate ridges; and pitted and lineated debris aprons.

Survey: Two study areas were selected to examine crater degradational morphologies: one in the northern mid-latitudes in Arabia Terra along the dichotomy boundary (30º-55º N, 0º-40º E) and one in the southern mid-latitudes in the highlands east of Hellas Basin (30º S-60º S, 110º-150º E). Out of 400 craters in the eastern Hellas region, as identified by [8], 103 had sufficient image coverage in THEMIS VIS images for more detailed examination, 62 of which contained features of interest. In the Arabia Terra study region, 106 craters out of 197 were included in the survey, 98 of which contained features of interest.

We identified 24 craters in the south study region and 6 craters in the north study region with lobate flows on their walls, primarily between 35º and 50º, and distributed throughout the region longitudinally. These craters typically contain several such lobes, appearing to flow from near the top of the crater rim, where mantling deposits are present [1-3], to a tapered point as the wall meets the floor. The size and shape of the lobes seem to be controlled by the local topography along the rim. The lobes are bounded by raised ridges, and their surfaces often have a pitted texture.

Eighty-nine percent of lobate flows in the eastern Hellas study region and 80% of lobate flows in the Arabia Terra region are found on pole-facing crater walls (Fig. 2). These craters are found only as far poleward as ~45º. We found three craters with lobes on an equator-facing wall, two in the eastern Hellas study region, and one in the Arabia Terra study region. These craters are found south of 50º in the eastern Hellas region, and north of 45º in the Arabia Terra region. This orientation dependence on latitude is consistent with previously determined orientation results for gullies and arcuate ridges in smaller craters [4, 7, 9].

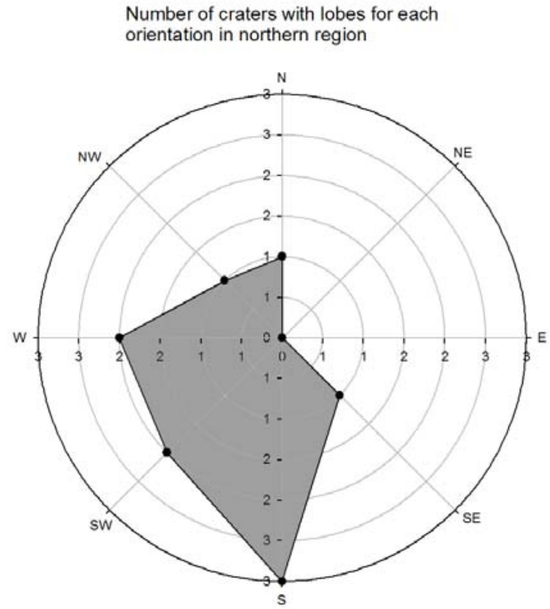
Channels (Fig. 1) are observed in 21 craters (20.4%) in the eastern Hellas study region, and 19 craters (17.9%) in the Arabia Terra study region. These crater channels often breach crater walls and extend outside the craters, as well as across crater floors. They typically have widths of 100-200 m. They have flat floors, are sinuous, and follow local topography (typically that of the crater floor or exterior rim). In some locations, simple branching relationships are observed. The channels are erosional landforms, cutting into preexisting terrains such as crater rims, ejecta blankets, and crater floor deposits. In some cases, narrower interior channels can be seen within wider channels. Mantling deposits are common in the regions where channels are found, and in some cases, the channels are infilled by smooth or pitted mantling materials. In some locations there appear to have been several stages of fluvial dissection; it is unclear whether the mid-latitude mantle has been dissected, but channel segments clearly dissect smooth, relatively uncratered sedimentary deposits.

Trough-like crater-wall valleys are found within 16 craters (15.5%) in the eastern Hellas study region, and 23 craters (21.7%) in the Arabia Terra region. These valleys typically start at the top of the crater rim and terminate where the wall meets the floor. They may have simple branching patterns, are flat floored, and are sometimes filled with a rough-textured material, often with lineations parallel to the valley walls. They are wider than the above-mentioned channels, typically a few hundred meters to a kilometer in width, and widen down slope as segments merge together.

Channels have a generally pole-facing trend in the eastern Hellas region, but not in the Arabia Terra region. No discernible latitude dependence was found for these features, i.e., no shift in orientation trend across the study area latitudinally, as seen for the lobate flows. Crater-wall valleys tend to follow an equator-facing trend in both study regions, with no discernible latitude dependence. Alcoves are concentrated on equator-facing walls in the eastern Hellas study region, but seem nearly equally distributed between pole- and equator-facing walls in the Arabia Terra region. No latitude dependence was found for the orientations of alcoves.

Discussion: A suite of distinct morphologic features is found to be characteristic of mid-latitude craters. These features (e.g., gullies, arcuate ridges, lobate flows, narrow channels, wider valleys, filled and unfilled alcoves, mantling deposits, and debris flows) appear to be related to the deposition and/or accumulation of ice with subsequent erosion due to mobilization of this ice. Which features develop in a crater is a function of latitude, crater diameter, crater wall slope, and crater rim topography. Lobate flows are common in mid-latitude craters larger than 20 km in diameter and are mostly pole-facing in orientation at lower latitudes, and equator-facing at higher latitudes, similar to the relationship between gully latitude and orientation [4]. These interrelationships suggest that cycles of deposition and re-distribution of ice [6, 7, 9] due to obliquity variations [5] are the likely formation mechanism for the observed features.

References: [1] Squyres S. W. and Carr M. H. (1986) *Science, 231*, 249-252. [2] Hartmann W. K. et al. (2003) *Icarus, 162*, 259-277. [3] Arfstrom J. and Hartmann W. K. (2005) *Icarus, 174*, 321-335. [4] Berman D. C. et al. (2005) *Icarus, 178*, 465-486. [5] Laskar J. et al. (2004) *Icarus, 170*, 343-364. [6] Mustard J. F. et al. (2001) *Nature, 412*, 411-414. [7] Costard F. et al. (2002) *Science, 295*, 110-113. [8] Barlow N. G. (2006) *LPSC XXXVII*, Abstract #1337. [9] Christensen P. R. (2003) *Nature, 422*, 45-47.



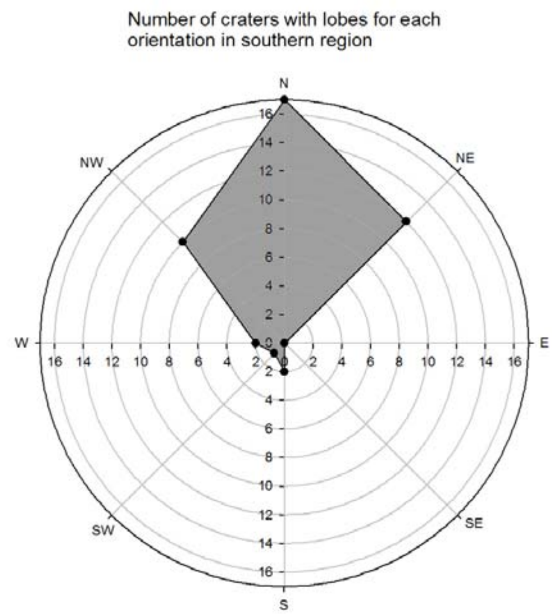


Fig. 2. Number of craters with lobes on walls of each orientation in the Arabia Terra study region (top) and the eastern Hellas study region (bottom). Pole-facing orientations are dominant in both cases.